HOUSE OF COMMONS

Seventh Session—Twenty-first Parliament
1952-53

SPECIAL COMMITTEE

on the

Operations of the Government

in the field of

ATOMIC ENERGY

Chairman: G. J. McILRAITH, Esq.

MINUTES OF PROCEEDINGS AND EVIDENCE [& Reports]
No. 1

FRIDAY, FEBRUARY 20, 1953
WEDNESDAY, MARCH 4, 1953

WITNESS:

Dr. C. J. Mackenzie, President, Atomic Energy Control Board and Atomic Energy of Canada Limited.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1953

72014—1

SPECIAL COMMITTEE

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Chairman: G. J. McIlraith, Esq.

Messrs.

Bourget	Kirk (*Digby-Yarmouth*)	Pinard
Brooks	Low	Stuart (*Charlotte*)
Coldwell	McCusker	Winkler—14
Gibson	Murphy	
Green	Murray (*Oxford*)	

(Quorum—8)

A. SMALL,
Clerk of the Committee.

ORDER OF REFERENCE

TUESDAY, February 17, 1953.

Resolved,—That a Special Committee be appointed to examine into the operations of the Government in the field of Atomic Energy; that the said Committee be empowered to sit during the sittings of the House and to print such papers and evidence from day to day as may be ordered by the Committee; and to report from time to time; that the said Committee consist of Messrs. Bourget, Brooks, Coldwell, Gibson, Green, Kirk (*Digby-Yarmouth*), Low, McCusker, McIlraith, Murphy, Murray (*Oxford*), Pinard, Stuart (*Charlotte*), Winkler.

Attest.

LÈON J. RAYMOND,
Clerk of the House.

72014—1½

MINUTES OF PROCEEDINGS

FRIDAY, February 20, 1953.

The Special Committee appointed to examine into the operations of the Government in the field of Atomic Energy met at 11.00 a.m. for organization purposes.

Members present: Messrs. Brooks, Green, Kirk (*Digby-Yarmouth*), Low, McIlraith, Murray (*Oxford*), Pinard, and Stuart (*Charlotte*).—(8)

In attendance: C. J. Mackenzie, C.M.G., M.C., D.Sc., F.R.S., President of Atomic Energy Control Board and of Atomic Energy of Canada Limited; G. M. Jarvis, M.B.E., Legal Adviser and Secretary of Atomic Energy Control Board and General Counsel and Secretary of Atomic Energy of Canada Limited; J. L. Gray, B.Sc., M.Sc., General Manager, and T. W. Morison, B.A., Chief of Administration Services, Atomic Energy of Canada Limited.

On motion of Mr. Green, seconded by Mr. Low, Mr. McIlraith was elected Chairman.

Mr. McIlraith took the Chair and thanked the Committee for the honour again conferred on him in being chosen Chairman. After reading the Order of Reference, he submitted, for expression of opinions by members, a proposed outline of future meetings of the Committee.

After discussion on the proposed outline, the Committee agreed:

1. That the next meeting be held at 10.00 a.m., Wednesday, March 4; and, if necessary, again on Monday, March 9. At that time, Dr. Mackenzie would appear before the Committee to review the history and operations in the field of atomic energy since 1949, when he last appeared before a Special Committee on Atomic Energy;

2. That Dr. Mackenzie's evidence be presented in three main parts: (1) General, (2) Isotopes, and (3) Power; the last to be given at Chalk River; and

3. That arrangements be made for an inspection visit to Chalk River, leaving Ottawa early on Friday morning, March 13, and returning from Chalk River Saturday, March 14.

The Chairman brought to the attention of members the broader scope of the Committee's Order of Reference as compared with that of the 1949 Special Committee on Atomic Energy and, in response to their inquiries, submitted:

1. That Mr. W. J. Bennett, President and Managing Director, Eldorado Mining and Refining (1944) Limited, would be available to appear before the Committee possibly on its return from Chalk River;

2. That the National Research Council did not come within the Order of Reference;

3. That, following the practice of the Special Committee on Atomic Energy set up in 1949 (Second Session), papers of interest to the Committee would be brought forward for the information of the members at subsequent meetings; and

4. That the size and nature of this Committee did not appear to warrant a sub-committee on agenda and procedure.

On motion of Mr. Low, seconded by Mr. Pinard,

Ordered,—That, pursuant to its Order of Reference, the Committee print, from day to day, 750 copies in English and 200 copies in French of its Minutes of Proceedings and Evidence.

At 11.35 a.m., on motion of Mr. Low, the Committee adjourned until 10.00 a.m., Wednesday, March 4.

WEDNESDAY, March 4, 1953.

The Special Committee appointed to examine into the operations of the Government in the field of Atomic Energy met at 10.00 a.m. The Chairman, Mr. G. J. McIlraith, presided.

Members present: Messrs. Bourget, Brooks, Green, Kirk (*Digby-Yarmouth*), Low, McCusker, McIlraith, Murphy, Murray (*Oxford*), Pinard, and Winkler.—(11)

In attendance: Dr. C. J. Mackenzie, President, and Mr. G. M. Jarvis, Legal Adviser and Secretary, both of Atomic Energy Control Board and Atomic Energy of Canada Limited.

Copies of the following documents were tabled and distributed to members of the Committee:

1. *The Atomic Energy Control Act, 1946* (Chap. 37);

2. *The Atomic Energy Regulations of Canada* (Order in Council P.C. 5513 of November 3, 1949); and

3. "Canada's Atomic Energy Project" (March 1953).

The Chairman called and introduced Dr. Mackenzie who read the following briefs into the record, copies of which were also distributed to members:

1. History of the Atomic Energy Program in Canada, the Relationships between the Organizations associated with that Program, and the Changes which have taken place since the last examination by a Special Committee on Atomic Energy (*Second Session—1949*); and

2. Production and Uses of Radioisotopes.

At the conclusion of Dr. Mackenzie's evidence, the Committee agreed to reserve its questioning thereon for the next meeting which was tentatively set for Monday, March 9, at 11.00 a.m.

At 10.55 a.m., on motion of Mr. Green, the Committee adjourned to the call of the Chair.

A. SMALL,
Clerk of the Committee.

EVIDENCE

MARCH 4, 1953, 10.00 a.m.

The CHAIRMAN: Gentlemen, I see a quorum. We have Doctor Mackenzie here to give evidence this morning.

I have copies of the Act and the regulations here—The Atomic Energy Control Act, and the Atomic Energy Regulations of Canada, and with your permission will have them distributed now. I also have a publication titled "Canada's Atomic Energy Project". It is a general description of the project. We will have it distributed, also; we will also distribute Doctor Mackenzie's brief before he reads it.

I will now call on Doctor Mackenzie.

Dr. C. J. Mackenzie, President, Atomic Energy Control Board; President, Atomic Energy of Canada Limited, called:

The CHAIRMAN: I don't think any introduction is necessary. We are all pleased to have him with us again as No. 1 witness.

Some Hon. MEMBERS: Hear, hear!

The WITNESS: Mr. Chairman and gentlemen. At the last meeting of the committe, it was decided they would like a review of the atomic energy program in Canada—its history, and the relationship of the Atomic Energy Control Board to the other organizations. We did present this evidence, you will remember, in 1949 at the November 8 meeting, so I will make my presentation briefer this year. You have this memorandum before you. Would it be satisfactory, Mr. Chairman, if I read it?

The CHAIRMAN: What is the wish of the members?

Agreed.

The WITNESS: Nuclear fission was discovered in Germany in 1939. In 1940 a small experiment was started in Ottawa by Dr. Laurence of the National Research Council, but there was no intensive effort toward the development of atomic energy in Canada until late in 1942, when a joint United Kingdom-Canadian team was established in Montreal under the administration of the National Research Council, to work in co-operation with United Kingdom and the United States toward wartime uses.

In 1944, it was decided that Canada should build a heavy water moderated reactor as a pilot plant for the production of plutonium. A site on the Ottawa river, at Chalk River, was selected, and work began immediately. Defence Industries Limited undertook the engineering design and supervision of construction, and was responsible for operation in the early stages. National Research Council conducted the research programme and supplied the basic scientific information and guidance.

In 1945 the first Chalk River pile, known as ZEEP (Zero Energy Experimental Pile) was brought into operation—the first nuclear reactor to operate outside the United States. ZEEP supplied much of the information necessary for the completion of the design of the larger reactor, NRX, which came into operation in 1947.

Atomic Energy Control Board.

The Atomic Energy Control Act, 1946, established the Atomic Energy Control Board, and gave it wide powers to conduct, supervise and control Canadian atomic energy developments.

Membership of the Board, 1952-1953, is as follows:

Dr. C. J. Mackenzie, President, Atomic Energy of Canada Limited and President of the Board.

George C. Bateman, Mining Consultant, Montreal, Quebec.

William J. Bennett, President and Managing Director, Eldorado Mining and Refining Limited.

Dr. Paul E. Gagnon, Director of the Department of Chemistry and Director of the Graduate School, Laval University, Quebec.

Dr. E. W. R. Steacie, President, National Research Council.

Mode of operation of Board.

The Board considered that if it were to supervise properly a program having so many ramifications it should not become too enmeshed in operating details. Moreover, it believed that it would be more efficient and more economic to make use wherever possible of the experience and facilities of other organizations rather than to set up duplicate facilities within its organization. Consequently, the Board staff has been kept to a minimum and it concerns itself mainly with over-all supervision of the program, security matters, legal questions, and liaison with external atomic energy organizations, particularly those in the United States and the United Kingdom.

Raw Materials Program.

In the raw materials field it was decided that, with proper security provisions, the development of Canadian radio-active mineral deposits could best be carried out under normal exploration and mining practices. Accordingly the Board framed the necessary regulations so that prospectors and mining companies would be encouraged to prospect for and develop uranium deposits. On the advice of the Board, the government offered to purchase acceptable uranium ores and concentrates at guaranteed minimum prices for a number of years, the latest extension of the guarantee period being to 1962. Every prospector and exploration and mining company, therefore, is a potential participant in the Canadian radioactive raw materials program. A great deal of work has been done by private interests, and many promising showings are under exploration and development.

Eldorado Mining and Refining Limited

The most important organization in the raw material field, of course, is the Crown company, Eldorado Mining and Refining Limited, which was organized in 1944, and which reports to Parliament through the Minister of Defence Production. Because of this company's experience in uranium mining and its operation of the only uranium refinery in Canada, it has been designated as the government purchasing agent for ores and concentrates produced by other companies.

The directors of Eldorado Mining and Refining Limited are as follows:

W. J. Bennett, President and Managing Director, Ottawa, Ontario.

R. T. Birks, Q.C., Toronto, Ontario.

Dr. W. F. James, Consulting Geologist, Toronto, Ontario.

F. D. Reid, Mining Executive, Toronto, Ontario.

E. L. Brown, Mining Executive, Toronto, Ontario.

C. G. Williams, formerly Professor of Mining, University of Toronto, Toronto, Ontario.

J. A. MacAulay, Q.C., Winnipeg, Manitoba.

Edorado operates transportation facilities by water and air for its operations at Port Radium, N.W.T. and Beaverlodge, Saskatchewan, through its wholly-owned subsidiary, Northern Transportation Limited. The directors of that company are as follows:

W. J. Bennett, President and Managing Director, Eldorado Mining and Refining Limited, Ottawa, Ontario, President.

F. W. Broderick, General Manager, Edmonton, Alberta.

H. H. Haydon, Treasurer, Eldorado Mining and Refining Limited, Ottawa, Ontario.

S. Bruce Smith, Q.C., Edmonton, Alberta.

Department of Mines and Technical Surveys

In the technical aspects of the raw materials program the Board has made use of the experience and facilities of the Department of Mines and Technical Surveys. The Radio-active Resources Division of the Geological Survey acts for the Board in collating information on the discovery and development of uranium minerals in Canada and gives technical advice and assistance to uranium prospectors. The Mines Branch of the department has set up a special division to investigate the best methods of concentrating ores found by Canadian exploration and mining companies. The Department, therefore, is making a very important contribution to the Canadian raw materials program.

I would also like to add that the Department of Mines and Technical Surveys cooperates in a very effective way with the Chalk River project in connection with the problems of chemical and physical metallurgy. We would like to pay tribute to the extraordinarily effective cooperation we get from Mines and Technical Surveys. We think that is a much wiser way to solve our metallurgical problems than to set up a large metallurgical section within the project. Mines and Technical Surveys have officers at Chalk River working with our scientific officers and they also carry on a great deal of work in Ottawa. We feel that this committee should understand the important work that this metallurgical branch is doing.

Chalk River Project

In the field of research into atomic energy application, Canada's only large scale establishment is the Chalk River project. Shortly after the Board was set up, it was made responsible for the future activities of this establishment. The Board considered that it should be maintained so that large scale research on the production and application of atomic energy could be carried out in Canada. It therefore requested the National Research Council, which since 1942 had directed the Canadian atomic energy research activities, to operate the Chalk River project as a research establishment on its behalf. Under Council operation Chalk River has become known throughout the world as an outstanding atomic energy research establishment.

NRU Reactor

Following the recommendation of the 1949 Special Committee that an additional reactor be constructed, plans were made for a reactor more powerful and with a higher neutron flux density than the NRX pile. Construction of

the new reactor was authorized early in 1951 and actual construction began that year. The new reactor, to be known as NRU, will use heavy water as a moderator, and will be adapted to extend greatly the range of possible research, as well as to increase production of plutonium and radioisotopes. It is expected that the cost of the new reactor and ancillary works will approximate thirty million dollars.

Atomic Energy of Canada Limited

The industrial aspects of the Chalk River establishment have been increasing, and there has been a growing feeling that large-scale industrial application of atomic power is closer at hand than had been expected. For these reasons, it was considered desirable that the project be segregated from other government activities and operated by a staff without outside responsibilities. Accordingly, the Board arranged, on the advice and instructions of the minister, for the incorporation of a Crown company, Atomic Energy of Canada Limited, which took over from the National Research Council on the 1st April 1952 the responsibility for the operation of the Chalk River establishment. The company was incorporated, pursuant to Section 10 (1) (a) of *The Atomic Energy Control Act,* 1946, by Letters Patent under Part I of *The Companies Act,* 1934. All of its issued shares except directors' qualifying shares are held by the Atomic Energy Control Board in trust for the Crown.

The directors of Atomic Energy of Canada Limited are as follows:

Dr. C. J. Mackenzie, President, Atomic Energy Control Board and President of the Company, Ottawa, Ontario.

Mr. W. J. Bennett, Member, Atomic Energy Control Board and President, Eldorado Mining and Refining Limited, Ottawa, Ontario.

Mr. E. R. Birchard, Vice-President (Administration) National Research Council, Ottawa, Ontario.

Mr. Rene Dupuis, Commissioner, Quebec, Hydro-Electric Commission, Montreal, Quebec.

Mr. G. A. Gaherty, President, Calgary Power Limited, Calgary, Alberta.

Dr. A. R. Gordon, Dean of the Graduate School, University of Toronto, Toronto, Ontario.

Mr. R. L. Hearn, General Manager and Chief Engineer, Hydro Electric Power Commission of Ontario, Toronto, Ontario.

Mr. Huet Massue, Manager, Economics and Statistics Department, The Shawinigan Water and Power Company, Montreal, Quebec.

Mr. V. W. Scully, Comptroller, The Steel Company of Canada Limited, Hamilton, Ontario.

University Research

In addition to furthering large-scale research at Chalk River, the Board has encouraged Canadian universities to carry on fundamental atomic energy research through financial grants to those institutions. The first grants were made to help defray the cost of major items of special equipment; e.g., a cyclotron at McGill University, a synchrotron at Queen's, a betatron at the University of Saskatchewan, A Van de Graaff generator and a linear accelerator at the University of British Columbia. Later grants were made for research with this special equipment, for other fundamental research and for work related to the treatment of uranium ores. The Board has arranged for its university grants to be handled through the National Research Council and the operating grants are administered in exactly the same way as the consolidated grants made by the Council from its own funds.

The amounts supplied are determined in relation to the programme of work on related subjects in progress in the particular university department. They are considered to be appropriate amounts for the best use of the equipment and facilities that are available. No major changes are contemplated from year to year. Each consolidated grant is administered by a responsible individual in the university, and the use of funds within the general intention of the grant is left to his discretion. The work in progress under these grants is reviewed once a year by senior scientists who submit written reports to the Council and the Board.

Distribution of Isotopes

At first distribution of radioactive isotopes was handled directly by the National Research Council, the operator at Chalk River, but when industrial applications began to increase it was decided to make special arrangements for their marketing. Under these arrangements, Charles E. Frosst and Company undertook the distribution to Canadian hospitals of certain specially purified radioisotopes intended for application to humans, while the Commercial Products Division of Eldorado, the radium sales organization of that company, took on the marketing of all other isotopes. The Commercial Products Division also carried out important development work on the industrial and medical applications of radioisotopes. That division was responsible for the development of the commercial model of the "cobalt bomb" which has been supplied to several hospitals in Canada and the United States. Because of the growing importance of radioisotopes it was decided last year that the Commercial Products Division should be transferred from Eldorado to Atomic Energy of Canada Limited. This transfer took place on the 1st August, 1952. The increase in the use of radioisotopes is indicated by the number of shipments made in 1952, over 1,100, as compared with about 270 in 1949.

Health Precautions in connection with Radioisotopes.

Radioisotopes, like radium, can cause serious injury if not handled properly. When the distribution of isotopes in Canada was first started the only organization with any experience in the field was the Atomic Energy Project, so that organization formulated the health precautions to be followed by users of radioisotopes and only released these materials to workers qualified and equipped to handle them safely. The Board's view has been that, except as necessitated by security aspects, such health precautions were a matter for enforcement by the appropriate health authorities. Discussions on the subject were opened through the Dominion Council of Health soon after the Board was established and progress is being made toward the settlement of regulations for administration by the health authorities. In the meantime, a special section devoted to this subject has been established in the Department of National Health and Welfare, and the project is co-operating with this section and with officers of the provincial health departments.

Civil Defence

Canada is not engaged in the manufacture of atomic weapons, but the Board is providing technical assistance and advice to those organizations (i.e., the Departments of National Defence and National Health and Welfare) responsible for Canadian atomic defence.

International Relations

International discussions of a political character on atomic energy and its control are the responsibility of the Department of External Affairs but the

Atomic Energy Project has provided technical advice and assistance when required. The Board maintains direct relations with the atomic energy organizations of the United Kingdom and the United States on such matters as the interchange and declassification of scientific and technical information.

Changes since 1949

As will be seen from the foregoing, the major developments since the Special Committee of 1949 held its sittings are:

(a) the authorization and commencement of construction of the new NRU reactor;

(b) the taking over by Atomic Energy of Canada Limited of operation of the Chalk River project;

(c) the expansion in the production and use of radioisotopes;

(d) the taking over by Atomic Energy of Canada Limited of the Commercial Products Division of Eldorado;

(e) the growth of interest in atomic energy as a potential source of industrial power.

The CHAIRMAN: Gentlemen, before we start questions, we have further evidence available on the production and use of radioisotopes, and, if it meets with your approval, we could go through that now and then that would make it available for all the members before questioning starts at the next meeting. It is just a matter of procedure. I take it then we can go ahead with the brief, Production and Uses of Radioisotopes.

The WITNESS: The production and use of radioisotopes is something that the committee is particularly interested in. I have this brief which I will read and then be very glad to answer questions. First, the production and uses of radioisotopes.

The large scale production of radioisotopes and their use in research, industry and medicine constitute an important atomic energy application which already has had its effect on the prosperity, comfort and well-being of mankind. These radioisotopes have been hailed by scientists as the most important analytical discovery since the invention of the microscope; they are recognized by industrialists as valuable aids in the measurement and control of many plant operations; and they are looked on by doctors as the treatment of choice for certain diseases. Indeed, the advantages resulting from the use of radioisotopes are already so great that many people are convinced that the ultimate benefits accruing from their use will alone be worth all the money spent on atomic energy developments.

Production

Radioisotopes, of course, are not something entirely new. Certain radioactive materials do occur naturally and a few of these, particularly the element radium, have been in use for a considerable time. A few radioisotopes have also been produced at great expense in large electronuclear machines called cyclotrons but it was not until the development of the nuclear reactor that radioisotopes became readily available in quantity and at a reasonable price.

Radioisotopes are produced in a reactor in two ways. The radioactive "ashes", i.e. the fragments from the fission of Uranium 235, are composed of many different radioisotopes and these can be separated one from the other by chemical methods. The general method of production, however, is to place a quantity of an appropriate substance in a container and expose this

to neutron bombardment in the reactor. The amount of radioactive material formed from this substance depends, among other things, on the number of neutrons per second bombarding it and the time of bombardment. The higher the neutron flux the shorter is the time that the substance has to be bombarded in order to obtain a given concentration of the desired radioisotope. This is much the same principle as that in the cooking of a roast—the hotter the oven the shorter is the time required to cook the roast. This oven analogy may be used to explain the important advantage that the NRX reactor possesses in the production of radioisotopes. As NRX is the "hottest" reactor (i.e. it has the highest neutron flux) of any known reactor engaged in isotope production, the time required to "cook" a particular sample is much less in NRX than in other reactors, sometimes only one tenth or one twentieth as much. A sample which would require say 6 month's "cooking" in NRX therefore would require a period of five or ten years in other reactors, and this is usually too long to wait for a particular sample.

Use of radioisotopes as tracers

Probably the best developed use of radioisotopes is their employment as tracers to indicate the course of particular chemical, biological or industrial processes. Most people are familiar with the military use of tracer bullets and they know that the luminous track left by these bullets indicates the course of ordinary bullets of the same calibre. Radioisotope tracer work is based on the same principle but here the bullets are sub-microscopic particles and they do not leave any visible track. They do, however, give off bursts of radiation which can be detected by means of sensitive, very sensitive electronic instruments called counters. So penetrating is this radiation that the presence of isotopes can be detected even through considerable thicknesses of material.

The quantity of these sub-microscopic bullets required for detection purposes is often extremely minute. For example it has been calculated that, if we were to take a teaspoonful of Carbon 14, a radioactive isotope of carbon, and mix this thoroughly with all the water in Lake Ontario, the amount of the isotope then present in one teaspoonful of this water could still be detected. This gives you some idea of the tremendous sensitivity of the tracer method. Sometimes, however, considerable quantities of radioisotopes are required, particularly where the radiation is to be detected through considerable thicknesses of material.

A few examples of tracers in agricultural research

By incorporating a small amount of radioactive phosphorus in a fertilizer and applying this fertilizer at various rates and times and then analyzing individual plants for total phosphorus and for radioactive phosphorus, agricultural scientists are able to determine the amount of phosphorus taken up by the plant from the fertilizer and from the soil. By such experiments they can determine the optimum amount of fertilizer required for a particular crop of a particular soil and the best time of application. By a similar procedure forestry scientists can determine the absorption of chemicals by roots of trees. Again, by placing a drop of a weak solution of Cobalt 60 on the hard shell wing of a pine weevil, entomologists are able to trace this insect and find out where it hibernates.

Tracers in medical research

In medical research by injecting radioactive sodium into the blood, doctors are able to follow the blood circulation in the human body and can locate spots where there is any restriction or impairment of circulation. Then again, since

some types of inflammation and tumours are known to absorb certain dyes, these dyes can be labelled with radioactive isotopes so that their presence can be detected externally with electronic detectors.

Tracers in industrial research and operations

Radioisotope tracers are also finding increasing use in industrial research and operations. For instance, by incorporating small amounts of radioisotopes in metal test pieces and checking any material abraded off for radioactivity, the automobile industry is able to determine very quickly the amount of wear in machine parts and to study the effect of lubricants of various kinds. Not long ago a large Canadian newsprint mill tagged a particular type of pulp fibre with radioactive iodine and thereby was able to determine the distribution of this fibre in a sheet of paper while the paper was running through the newsprint machine at a speed of 1,700 feet per minute. Radioisotopes have also been used to good effect to locate obstructions in underground oil pipe lines being built across Canada. To scrape away any deposits occurring inside such pipes it is customary to force through them a tight-fitting scraper called a "pig". If a strong radioisotope source is attached to this pig, then if the pig is stopped by some obstruction or deposit which it cannot remove, the position of the obstruction can be located on the surface of the ground by instruments capable of detecting the radiation emitted by the radioisotope. This technique may obviate the necessity of tearing up miles of pipe to find an obstruction.

Radioisotopes in measuring and controlling devices

Another use of radioisotopes which is finding increasing application, particularly in industry, is their employment in measuring devices of various kinds. As mentioned earlier, the radiation from certain radioisotopes can penetrate considerable thickness of material. However, the percentage of radiation penetrating a particular material depends on the thickness of this material. By using a specially calibrated detector, therefore, it is possible to determine the thickness of material placed between the radioactive source and the detector. Such thickness gauges are finding increasing use in the paper making industry, for the continuous measurement of paper thickness even when the paper is moving through the device at great speed. Indeed, arrangements can be made so that the device not only measures but also controls the thickness of the paper, thus ensuring a greater degree of uniformity in the product. Similarly, radioactive isotopes can be used to indicate the level of oil in refinery tanks, and to make other measurements such as the progress of corrosion on the inside of tanks which otherwise would not be available for inspection.

Radiography

Another example of the use of radioisotopes for measurement purposes is industrial radiography, the inspection of welds and castings for flaws. The technique used is just the same as that used in the taking of an x-ray photograph. The source of radioactive material is placed on one side of the casting and a special photographic film is placed on the opposite side. Any flaws in the casting will permit a greater percentage of radiation to reach the film and this will show up clearly when the film is subsequently developed. This inspection work can be carried out more quickly with radioisotopes than with x-ray machines and it is possible to use these materials in places where x-ray machines cannot be used because of their size.

Medical uses of radioisotopes

Radioisotopes also have important value as therapeutic agents. This is based on the fact that though the radiations given off by radioactive materials are injurious, they are usually more injurious to diseased tissue than to normal

healthy tissue. Consequently with proper safeguards the radiations from such materials can be used to kill diseased tissue without causing serious injury to neighbouring healthy tissue at the same time. This, of course, is the theory on which the use of radium for medical purposes is based. Radioisotopes, however, for example radioactive cobalt, can provide a much more intense beam of radiation at much less cost. Consequently radioactive cobalt is beginning to replace radium and high voltage x-ray machines, particularly in the treatment of deep seated tumours which cannot be treated satisfactorily by the other methods.

Some radioisotopes—they are very few—can be taken internally for the treatment of certain diseases. For example, since iodine tends to concentrate in the thyroid a small amount of radioiodine taken internally will tend to concentrate in the thyroid and the radiation from this iodine will be effective in the treatment of certain thyroid disorders.

The above examples by no means exhaust the possible uses of radioisotopes in research, industry and medicine, but may give some idea of the benefits that they can bring to mankind.

Isotope shipments

Shipments of isotopes through the Commercial Products Division of Atomic Energy of Canada Limited were being made in the last quarter of 1952 at the rate of about 50 per month, or 600 per year. In addition, some 500 shipments per year are being made through Charles E. Frosst & Company, and for project purposes. The average amount of active material per shipment is now much higher than it was a few years ago. (3)

I think that is very important. You remember that in 1949 we shipped 249 per year. We are shipping now over 1,100 per year, and the shipments are larger than the previous ones.

Canadian recipients of isotope shipments include:

Hospitals	14
Industrial Laboratories	39
Universities and Colleges	19
Research Centres	6
Government Laboratories	20
Miscellaneous	4

Making a total of 102.

It is thus apparent that many more hospitals, colleges and industries in Canada are now using isotopes in their work, as compared with the number using them a few years ago. A further increase is expected in the number of users as well as the number of isotopes used, resulting from the A.E.C.L. policy of assisting customers to find applications for isotopes in the simplification of their operations and in the development of new techniques.

Many shipments are routine, others illustrate special and interesting applications, some of which will be mentioned in succeeding paragraphs.

Cobalt Beam Therapy Program

A.E.C.L. makes available a complete equipment, including radioactive source, operating equipment and installation service. The source is in the 1,000 to 2,000 curie range whereas ordinary shipments are usually in the millicurie range—that is a thousandth of a curie. Such units are now in use at London, Ontario; Saskatoon, Saskatchewan (source only supplied by A.E.C.L.); Vancouver, B.C.; New York, U.S.A.; others will shortly be installed at Chicago, Winnipeg and Minneapolis, and there are many others.

A detailed list is appended to this memorandum.

Cobalt Source for Sterilization

A large source of low specific activity Cobalt^{60} has recently been supplied to the University of Michigan. This is believed to be the largest source of radioactive material ever put to commercial use. A total activity of about 10,000 curies was shipped in a single container.

I might say that 10,000 curies is equal to 10,000 grams of radium in its radiating effect. A hospital that has two or three grams has quite a lot of radium. In this one source we have 10,000 curies which is the equivalent of 10,000 grams of radium in its radiating effect. This source will be used to further studies on sterilization of food stuffs, drugs and in other experimental work.

I might say that this is something we are extraordinarily interested in because we are constantly looking for a use for the radioactive isotopes or fission products which we have in such large numbers. To find some use for the bulk of fission products will be to our great advantage.

The next two pages contain a description of some of the short-lived isotopes. Do you think I should read it?

Hon. MEMBERS: Yes.

The WITNESS: This is an example of some of them to give you an idea of what they are used for.

Short Lived Isotopes

Sodium^{24} (half life 14·8 hours) has found application in the radiography of very thick sections because of its very penetrating gamma radiation (Aluminum Company of Canada, Kingston).

One example of the application is that of a large casting costing many thousands of dollars which needed to be inspected and could be inspected in no other way.

Sodium^{24} is short-lived and must be transported very quickly and used before its life has gone.

Palladium^{109} (half life 13 hours) has been shipped from A.E.C.L. to University of Michigan for studies in the effect of ionisation within cylinders of combustion engines.

That is a study of what takes place in the cylinder of an internal combustion engine.

Mr. GREEN: What does that term "half-life" mean?

The WITNESS: All radioisotopes decay. They decay because they are unstable, and as they decay they give off radiation and in order to get an idea of how long they are going to last, one must have some yardstick and the yardstick used is the length of time in which half of the existing life will decay. If you start with 100 units then the activity of this at the end of seven days will be 50.

Mr. PINARD: Why half?

The WITNESS: At the end of the next week there would be 25 and in the next seven days it would be 12½. It just gives you an idea of how rapidly it decays and the reason you cannot make it absolute is because you never know where the end is. You have to stop somewhere. That is the way we have of measuring the lifetime.

Some, for instance, radium is around 1,000 years. Plutonium is around 2,000 years, and Carbon^{14} is 5,000 years and you can have isotopes with only a few seconds. If you were to treat a person with radium—you would not want to treat them with an isotope that was going to be in their body for a long time, but with a short half-life it would die off, whereas if you treated them with Carbon^{14}, it would stay there. Does that answer the question?

Mr. GREEN: Yes.

Copper^{64} (half life 12·8 hours) has been shipped to University of Utah for metabolism tests.

All of these short-lived isotopes naturally require special shipping arrangements to minimize decay in transit.

Other uses of radioisotopes

(1) Medical Therapy—Cobalt^{60} in beam therapy units; in needles, tubes & special applications.
Iodine ^{131} for intravenous injections.
Gold^{198} for intravenous injections and to replace radon.

(2) Chemical Tracers and Process Control—

Silver^{110} for pulp and paper research

Iodine^{131} for biological studies

Phosphorus^{32} for dermatology, agricultural research (fertilizer uptake and tracing of animal food uptake).

Sulphur^{35} has uses similar to phosphorus.

Carbon^{14} has very diverse uses.

You can say that long lived Carbon^{14} is useful in experiments where you wish to carry on experiments for a long time.

(3) Luminous Compounds—Strontium^{90} and Thallium^{204} are now used extensively as a radium substitute.

They have reasonably long lives.

(4) Static Eliminators—Strontium^{90} and Thallium^{204} are used as a radium substitute and as a substitute for electronic static eliminators.

(5) Industrial Radiography—Cobalt^{60}, Iridium^{192}, Tantalum^{108} are widely used in radiography of castings and pipeline weldments.

(6) Neutron Sources —Polonium^{210} and Antimony^{124} produce useful sources of neutrons for many research applications.

(7) Liquid Level Gauges and Thickness Gauges—Beta emitters such as Strontium^{90} and Thallium^{204} are finding many uses in the control and measurement of sheet material such as paper and metal foil.

(8) Tagging of Animals and insects—Useful information on the habits of certain insects has been obtained by tagging them with active material and subsequently locating them in their natural surroundings; e.g. pine weevil and mosquotes. A program is under way for the large scale tagging of fish to determine migration and spawning habits.

Mr. GREEN: How do you locate the mosquitoes after they have been tagged?

The WITNESS: By radioactive counters; you can gather them and pick them out and find the ones which are radioactive and the ones which are not.

(9) Sterilization—Gamma or beta radiation may be used in the sterilization of drugs where heat sterilization would produce a deterioration in the product. Food sterilization by radiation is in the experimental stage.

As I have said before, that is one of the projects in which we are particularly interested because, if it succeeds, it will be one of the projects in which a large quantity of fission products might be used. We have large quantities, and they are now a source of expense to us; but we hope to turn them into something which will bring us in revenue.

In the appendix there are listed the Cobalt 60 therapeutic units already installed.

The CHAIRMAN: We can either start the questioning now or leave it until the next meeting. We have about five minutes more time.

Mr. MURPHY: Why not leave the questioning to the next meeting, Mr. Chairman?

The CHAIRMAN: Yes, we can leave the questioning to the next meeting; and if we could start with page one of the evidence, it would perhaps produce a more systematic way of conducting the questioning.

(At this time discussion continued off the record.)

The CHAIRMAN: A motion for adjournment is now in order.

The meeting adjourned.

APPENDIX

LIST OF "COBALT BOMBS" ALREADY INSTALLED

(NOTE: All bombs supplied with high activity radioactive cobalt from NRX reactor. Bombs designed by Commercial Products Division of Atomic Energy of Canada Limited (formerly Commercial Products Division of Eldorado Mining and Refining Limited) except where noted.)

1. University Hospital, Saskatoon, Saskatchewan.*
2. Victoria Hospital, London, Ontario.
3. Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.**
4. British Columbia Cancer Institute, Vancouver, B.C.
5. Montefiore Hospital, New York, N. Y.

* Unit designed by scientists of University of Satkatchewan.

** Unit designed by American engineers and scientists.

List of "Cobalt Bombs" expected to be installed in the next few weeks.

(NOTE: All bombs designed by Commercial Products Division, Atomic Energy of Canada Limited and supplied with high activity radioactive cobalt from NRX reactor.)

1. Cook County Hospital, Chicago, Ill.
2. Manitoba Cancer Relief and Research Institute, Winnipeg, Manitoba.
3. University of Minnesota Hospitals, Minneapolis 14, Minnesota.